THE TWO NEW INTERSTATE BRIDGES ACROSS THE OHIO RIVER AT LOUISVILLE, KENTUCKY

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The subject of a new bridge, or new bridges across the Ohio River at Louisville has been of prime interest for quite a few years. It now appears that, at long last, the development of the Interstate System will provide the impetus and overcome the financial barriers so as to permit the immediate construction of not one, but two new bridges.

Both structures are on the Interstate System; both are located in the Louisville, New Albany, Jeffersonville Metropolitan Area. The preparation of plans and specifications for each structure are so closely scheduled that they actually overlap and this close scheduling of the design periods in turn will result in both structures being under construction at the same time. The Louisville, New Albany, Jeffersonville Metropolitan Area will therefore have the unique experience of watching two major bridges, each providing six traffic lanes, pushed across the Ohio River within a period of 24-36 months. In what we might term normal times, a community the size of the Louisville Metropolitan Area would think itself doing very well to get one bridge in a 20 year period.

To fully comprehend what two new bridges will mean to the motoring public and to the Transportation Industry in general, it might be well to take a look at the present facilities. The Louisville area is, at present, served by two structures providing a total of six lanes over the river. The older structure, owned and operated by the K&I Terminal Railway Co. as a toll bridge, is a combined railway and highway structure. It provides two traffic lanes. It was built long before 1900 and has served the public well, but the great advance made in motor vehicle travel following the First World War rapidly rendered it obsolete. This resulted in the construction of a second bridge during the late twenties. This structure, now called the Clark Memorial Bridge, is operated as a four lane bridge, but the nine foot lanes are now considered substandard and entirely too narrow to cope with the ever-increasing width, weight and speed of modern motor vehicles. The Clark Bridge was financed and built as a toll facility under the jurisdiction of the Louisville Bridge Commission. In 1946 the bridge was freed of tolls and turned over to the State of Kentucky as part of the primary system. The addition of the two new bridges will increase by 200% the number of lanes available to cross river traffic.

The very natural feeling of joy and exhilaration of the motoring public at having a free bridge was very short lived. Hardly had the tolls been removed when it became apparent that the violent up-surge in vehicle registration occasioned by the resumption of the manufacture of automobiles following the close of World War II, would in a very short time result in traffic jams of unprecedented proportions. A second and highly important contributing factor to this critical situation was the tremendous economic change which developed in the area during World War II and which was to be greatly accelerated after cessation of hostilities. Millions of industrial dollars were being poured into the area through expansion of plants like Ford and International Harvester. General Electric began construction of the great Appliance Park. The Aluminum Industry, already an important factor in the industrial life of the community, enjoyed a tremendous expansion. It became increasingly obvious, to put it simply, that something had to be done.

Between 1946 and 1956, numerous plans were initiated in an attempt to finance another bridge which it was hoped would relieve the mounting traffic jam. Traffic surveys were made and preliminary studies prepared, but the presence of a free bridge seemed to preclude the construction of a toll bridge. The funds available from state and federal agencies were barely able to meet the normal demands of the primary and secondary systems, so the prospect of a free bridge constructed out of the usual highway revenues seemed very remote. However, during 1956 an agreement was reached on a plan whereby the Federal Bureau of Public Roads would match state funds for the Indiana and Kentucky approaches and the main river spans would be built by the Indiana Toll Bridge Commission as a toll facility.

No sooner had this tri-part agreement been executed and engineering contracts awarded when the Federal Government announced its great Interstate Program under the terms of which the Federal Government would absorb 90% of the cost of projects approved for the giant Interstate System.

New traffic and route studies had to be ordered and pursuant to an agreement between the two states, the firm of Edwards and Kelsey were retained for this purpose. The principal recommendation emanating from their report was that two six-lane bridges should be built—one in the west end of the city connecting New Albany, Indiana, and Louisville in the vicinity of Shawnee Park and the other connecting Jeffersonville, Indiana, and Louisville approximately 1000-1500 feet down stream from the existing Big Four Railroad Bridge. The report further recommended that the bridges were to be interconnected by a system of expressways in Louisville on the Kentucky side and a similar but less elaborate system in New Albany and Jeffersonville on the Indiana side. Thus, these two new interstate bridges, together with the expressways, would comprise a fully integrated limited access facility which would not only serve the Louisville Metropolitan Area but would also tie together the three interstate routes in the area. Actually, studies and plans for a system of expressways had been under consideration in Louisville since about 1945 and construction of the North-South Expressway already started. Fortunately, the basic plan of the North-South Expressway was such that it could be readily incorporated in the comprehensive system recommended in the Edwards Kelsey Report.

Following general acceptance of this report and coupled with an intense desire on the part of highway officials from both states "To Get Going and Get Things Done", our firm was ultimately selected to prepare preliminary, as well as contract plans, for both main river crossings, the approaches for both bridges on the Indiana side and a portion of the approach to the New Albany Bridge on the Kentucky side. The Jeffersonville Bridge on the Kentucky side connects directly to an intricate interchange, which will be designed by others. Pursuant to an agreement entered into between the two states and concurred in by the Bureau of Public Roads, the New Albany Bridge will be handled through the Indiana State Highway Department and the Jeffersonville Bridge will be handled through the Department of Highways of the Commonwealth of Kentucky.

Before discussing each of these projects in more detail, I would like for you to take a look at a map of the Louisville Metropolitan Area in order to have in mind the interstate pattern and other major factors which influenced the selection of the two bridge locations.

I.R. 64 is an East-West Highway extending from Norfolk, Virginia, through Louisville to St. Louis, Missouri. This route enters the Louisville Area from the East through Shelbyville and Middletown and heads toward the main business section in a northwesterly direction until it joins the Riverside Expressway, probably in the vicinity of Ohio and Adams.

I.R. 65 extends from Chicago to Mobile, Alabama, via Louisville. It comes in from the North as part of the Jeffersonville Expressway and in the City of Louisville proper forms the North-South Expressway, which in turn connects with the Kentucky Turnpike continuing Southward, via Elizabethtown and Nashville.

I.R. 71 connects Cincinnati and Louisville. It enters the Louisville Area from the North and East and connects with the Watterson Expressway near Brownsboro Road, thence on to the river front as part of the Riverside Expressway.

Interconnecting these three interstate routes on the Louisville side are the Watterson Expressway and the outer belt, and on the Indiana side, a belt line extending around New Albany from a connection with I.R. 65 to a connection with I.R. 64 coming off the New Albany Bridge. These belt line routes, together with the three interstate routes, form an integrated expressway system for the area and were a highly important factor in the final selection of the two bridge sites. Equally important were relative cost studies made for alternate locations for both bridges from a common point on the Kentucky side to a common point on the Indiana side. Recommendations on bridge locations were submitted to the Bureau of Public Roads and approval of the two sites, as shown on the map, was subsequently received.

Major bridge projects of this type are designed to the high standards created for the Interstate System. They must be able to accommodate the traffic needs of 20 years hence. They must provide horizontal and vertical clearances adequate to accommodate the ever-increasing volume of shipping on the Ohio River; and, in our opinion, they must result in facilities which will be architecturally pleasing to the traveling public and blend harmoniously with the surroundings.

The Louisville-New Albany Bridge

Numerous conferences with members of the Bridge Committee of The American Waterway Operators, Inc. and the Corps of Engineers revealed several important facts and river characteristics which would greatly influence the final choice of span pattern.

1. The approved route is located at a bend in the river and today's tows approaching 1200′ in length present a major problem in navigation whether the river is partially obstructed or not. Tows are actually pushed and maneuvered from the rear, and any change in direction is necessarily a kind of skidding action and must be anticipated well in advance. Longer navigation spans are therefore required in a bend of the river rather than in say a straight stretch.
2. This site is below Lock and Dam 41 and subject to sudden fluctuations in water level, which would not be as prevalent above the dam. This creates tricky currents and is further argument for adequate navigation spans.
3. This site requires two navigation spans since navigation characteristics dictate use of two channels. During flood stage, upstream tows hug the Kentucky shore, while southbound tows are operated near the Indiana shore as they come over the dam.

These conferences eventually resulted in two possible solutions:

1. The establishment of a span pattern which would provide two 780 foot clear channels.
2. The navigation interests, while they made it very clear that they favored the two-channel arrangement, offered an alternative suggestion of a single 1000 foot channel.

We thought we knew the answer to the 1000 foot span, but nevertheless made extensive studies which bore out our fears. We had to discard, primarily because of cost, a 1000 foot tied arch with tail spans of 450± feet. Additionally, the long center span, together with adequate tail spans, would result in approximately 1900 feet of main bridge, whereas 1600 feet seems adequate.

At the same time, we had studies in progress on the two-span arrangement. The first solution which came to mind was understandably the two-span continuous truss. This seemed to be the most obvious solution and at first glance probably the most economical. While such a structure is impressive in size, I believe most of you will agree that it leaves a lot to be desired from an aesthetic point of view. We made very careful cost estimates of this structure.

We likewise studied twin tied arches with anchor or tail spans. This arrangement had to be discarded because the tail spans interferred with the curved approach on the Kentucky side and the widening required for ramps on the Indiana side.

These considerations and limitations brought us to the study of twin tied arches without tail spans. Comparative estimates indicated this arrangement to be much more economical than the 1000 foot span and within 2-3% of the estimated cost of the two-span continuous truss. For all practical purposes then, the relative costs between the continuous truss and the twin arches appeared to be virtually a standoff.

After review by the State Highway Departments and the Bureau of Public Roads, this design was selected as best suited to the conditions at this site and work is going forward on the plans.

In all of our studies of various span patterns and different trusses, we *also* considered the relative merits of a single deck of six lanes versus a double deck carrying three lanes on each level. The double deck was finally selected primarily because of economy. Great savings in substructure costs are readily apparent due to less width. Superstructure costs are decreased through use of shorter floor beams, and through approach costs are increased because of the two deck construction, savings in the main bridge spans offset increased approach costs by more than one half million dollars in the selected design. The double deck feature is further desirable from an aesthetic viewpoint and from a standpoint of safety.

The selected design consists of two 800 foot tied arch double deck spans with two 42 foot roadways and 2 foot 6 inch escape walks on each side. No pedestrian traffic is contemplated except in case of emergency. The 42 foot roadway permits three 12 foot lanes and six feet to be divided in an as yet undetermined manner on each side. This width will permit three lane operation at reduced speed even though a disabled vehicle is against a curb. At this time, we contemplate using approximately a 3¼″ bridge rope in pairs for these hangers. We are also investigating the use of a bridge strand which may permit a reduction to a 2¾″ or 3″ size diameter. The arch truss is approximately 30 feet in depth at the center and approximately 70 feet at the ends. At the portal, the truss is approximately 70 feet in depth.

Marine borings for the main piers are now in progress, and from our knowledge of existing and available data on the Ohio River at this location, we do not expect any serious foundation problems. Borings on the actual line and at the exact pier locations may alter that assumption. With the piers set from 5-10 feet into solid rock, it appears as though the main piers will be about 125 to 150 feet high. Vertical clearance at normal pool will be 92 to 100 feet. At 1937 flood stage the vertical clearance will be 17 to 25 feet.

In developing the preliminary studies for this bridge, extensive use has been made of the electronic computer, particularly in the stress analysis of the various trusses. This modern marvel has made possible the accurate investigation of many alternate studies and will expedite the solution of many design problems. We expect to make full use of this equipment in the development of the final designs. Further mention of the use of the electronic computer will be made in my closing remarks about both bridges.

After approval of the preliminary plans by the various agencies, we will proceed with final plans, and it is anticipated that contract plans and specifications for the construction of the main piers will be completed and advertised for letting in late spring or early summer. Plans for the main superstructure will follow and probably let as a single contract. The approaches on each side of the river will be packaged into one or more contracts and unless unforeseen delays are encountered, we should see all work under contract by late 1959 or early 1960. It is estimated that the overall construction period will be about two years.

The Louisville-Jeffersonville Bridge

This bridge is scheduled to lag behind the New Albany Bridge by some 90-120 days in each of the various steps which lead to its ultimate opening to traffic. So perhaps it is a little early to discuss exactly what we plan to submit for consideration by the various agencies. The War Department hearing in regard to navigational clearances has been held and a permit for the construction should be issued in the foreseeable future. No decision has been reached on the type of trusses to be used, and my remarks concerning this bridge must be necessarily conned to generalities and more or less of a review of our progress to date.

One might assume that since the two bridges in this discussion are both over the Ohio River and both carry six lanes of traffic, and are in the same general vicinity, that they might conceivably be similar in design. If this were the case, I can assure you that the consultants would be most happy. Unfortunately such is not the case. You will recall that the main structure at New Albany is about 1600 feet in length, the Jeffersonville site requires about 2500 feet in main bridge—more than half again as long.

The same series of conferences with the Bridge Committee of the American Waterway Operators and the Corps of Engineers in connection with the first bridge revealed that we were again faced with a two-channel requirement for navigational purposes. In this case, however, the two-channel spans would have to be separated by an intermediate span due to the distance between the channels. The existence of two other river crossings, the Clark Memorial Bridge and the Big Four Railroad Bridge, on either side of this location was a major consideration in determining span lengths for this bridge.

This is the Clark Bridge with one navigation span of 800 feet for normal operations near the Kentucky shore. River traffic moves near this shore in order to properly line up and approach the locks on this side. During high water, the traffic goes over Dam 41 and must necessarily stay further out in the river in order to be in proper position for rounding the bend and proceeding on over the dam. The Clark Bridge therefore provides a second navigation span of 800 feet near the Indiana side. Further upstream is the Big Four Railroad Bridge, which likewise provides two openings to accommodate both navigational situations. These two existing structures were used in establishing control points for the substructure units of the new bridge which lies about 1000 feet downstream from the railroad bridge.

We are again studying the various possibilities in types of trusses and single deck versus the double deck. Present indications point toward a multiple cantilever, similar in many respects to the existing Clark Bridge. The span arrangement would be 300 feet—700 feet—500 feet—700 feet—300 feet or a total length of 2500 feet. The two 700 foot navigational spans would provide clear openings of about 680 feet. The center span of 500 feet could also be used by the smaller barges under good river conditions. This particular arrangement would allow erection of the navigation spans with little or no obstruction to river traffic. This, of course, is one of the advantages of the cantilever type of truss. The cantilever arms are 155 feet and the suspended spans 390 feet. Minimum vertical clearance at normal pool will be about 71 feet.

Construction of the main piers should present more of a problem than the superstructure. Our worst condition, from existing data available to us shows that we will have about 40 feet of water and about 40 feet of overburden to go through to found on rock. With the piers some 70 feet out of the water, it means our tallest substructure unit will be better than 150 feet high. Borings are now in progress and data so obtained will give us a more realistic picture of what to expect with regard to the foundation problems.

As in the case of the New Albany Bridge, we are carefully studying the possibility of double deck construction with the same cross-section as provided for that bridge. We can see about two million dollars in saving through use of the double deck. This may be totally wiped out through increased cost of the approaches, not so much on the Indiana side as on the Kentucky side where you come off the bridge immediately into an intricate interchange. The effect of double deck bridge construction on the interchange is being studied by others, and before we can present alternate cost studies to the two departments, this material must be carefully assembled and analyzed. The main bridge, with the addition of one span to get over the New Albany Floodwall, is presently estimated to cost between 10 and 12 million dollars.

We are also studying the possible use of a series of tied arches for this location, and at this early stage, I cannot give you a realistic estimate of the relative costs between the two types of trusses under consideration.

Regardless of which way this bridge ultimately goes—multiple cantilever or tied arches, double deck or single deck—all contracts for construction should be let by spring or early summer of 1960 and the overall construction period should be about two years.

Use of Electronic Computer

As mentioned earlier, we have used the electronic computer rather extensively in developing preliminary studies for these bridges. In the preparation of contract plans and final designs, we expect to make use of several bridge geometry programs which have been developed by our own computer section. One of these is a curved bridge geometry program which has been used to compute stringer lengths between skewed piers under curved roadways, as well as the distances between centerlines of bearings along the stringers. This program can also be used to give ordinates from a curved control line to the centerline of any stringer at designated intervals, compute elevations at the top of the roadway slab at the centerlines of bearing and either the bridge seat elevation or bearing assembly height, also to compute the elevations to the top of the roadway slab and the top of beam at predetermined fixed intervals of length along the stringers. This information may be corrected for dead load deflection and beam camber by the program to give as output the slab thicknesses and finishing screed elevations.

Four other programs have been developed by our staff which give similar output to that program just mentioned but for different criteria for superelevation and crown of roadway. Two of these programs are for structures with straight alignment while two are for curved structures.

A sixth bridge geometry programs which we are using is the so-called California traverse program which can be very effectively used in establishing control points both on and off the structure.

We are using, at present, three programs in the design of the main river spans of the two bridges. Two programs developed at the University of Houston are being used to determine stresses and influence ordinates for the statically indeterminate tied arches of the New Albany Bridge. The basic truss analysis program rapidly computes stresses in the members of any simple truss span or in any redundant truss with the redundancy removed.

A program developed by the California Department of Highways is being used to design composite welded steel plate girder sections for the approaches. This program not only designs the required web thickness and flange areas but also can be used to determine the most economical depths for various spans.

A fourth program which may be used for the design, if continuous reinforced concrete T-Beam Spans prove feasible in any part of the approaches, has been developed by the Oregon State Highway Department. This program computes for continuous beams having variable moments of inerita, the dead load moments for shears at each tenth point of length from 2 through 5 spans. The same program gives influence ordinates for determining live load moments and shears at the supports and each tenth point of span. It is necessary then for the designed to determine only the required reinforcing steel.

It is entirely probable that other programs may be used for the design of the piers, the computation of reinforcing steel weights and various other minor details of the projects.

Materials

The most recent developments in materials, particularly in new steel alloys, will be employed to the fullest extent economically feasible in the proposed bridges. As an example, specifications for the arch ties of the New Albany Bridge will probably require that they be fabricated from heat treated high strength alloy structural steel having a working strength of approximately two and one half times that of material normally used. It is further proposed to make extensive use of welding in the basic fabrication which will result in a material saving in weight and an improvement in the general appearance of the steel trusses. Weldable alloy steels will be used and inspected by radiological methods. Field connections will probably be high strength bolts.

Construction Supervision

Under the terms of our contracts on these two bridges, the states will provide the staff for supervision of construction. We, however, will furnish one top flight man to each project, who is experienced in heavy construction of this type. If requested, we are further obligated to provide a complete field force for supervision and inspection of the work and materials going into the projects. Needless to say, there is a great deal of interest in these two bridges on the part of our Louisville staff, and we have a long line of volunteers for service in the field during the construction period.

Bridge building, regardless of the size of the bridge, always seems to present new, but not insurmountable problems, and I am sure we will have our share of anxious moments on these two. Nevertheless, all of us who are directly connected with the projects and over 500,000 sidewalk superintendents in the Louisville Metropolitan Area, are looking forward with anticipation to the day when Kentucky-Indiana relations will be further enhanced by the completion of two additional links between these two great states.